



## Radioactivity in the Risø District July-December 2010

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# Radioactivity in the Risø District July-December 2010



## Risø-R-Report

Sven P. Nielsen, Kasper G. Andersson and Arne Miller  
Risø-R-1779(EN)  
June 2011



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**Title:** Radioactivity in the Risø District July-December 2010  
**Division:** Radiation Research

**Risø-R-1779(EN)**  
**June 2011**

**Abstract (max. 2000 char.):** The environmental surveillance of the Risø environment was continued in July - December 2010. The mean concentrations in air were:  $0.34 \pm 0.26 \mu\text{Bq m}^{-3}$  of  $^{137}\text{Cs}$ ,  $2.58 \pm 1.09 \text{ mBq m}^{-3}$  of  $^7\text{Be}$  and  $0.23 \pm 0.19 \text{ mBq m}^{-3}$  of  $^{210}\text{Pb}$  ( $\pm 1$  S.D.;  $N = 26$ ). The depositions by precipitation at Risø in the second half of 2010 were:  $0.045 \text{ Bq m}^{-2}$  of  $^{137}\text{Cs}$ ,  $744 \text{ Bq m}^{-2}$  of  $^7\text{Be}$ ,  $47.0 \text{ Bq m}^{-2}$  of  $^{210}\text{Pb}$  and  $< 1.2 \text{ kBq m}^{-2}$  of  $^3\text{H}$ . The average background dose rate (TLD) at Risø (Zone I) was  $65 \text{ nSv h}^{-1}$  compared with  $58 \pm 7 \text{ nSv h}^{-1}$  ( $\pm 1$  S.D.;  $N = 4$ ) in the four zones around Risø.

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Table 1. Radionuclides in ground level air collected at Risø (cf. Figs. 1, 1.1 and 1.2), July - December 2010. (Unit:  $\mu\text{Bq m}^{-3}$ )

Date	$^7\text{Be}$	$^{137}\text{Cs}$	$^{210}\text{Pb}$
28-Jun-10 – 05-Jul-10	3131	0.224	170
05-Jul-10 – 12-Jul-10	3616	0.221	253
12-Jul-10 – 19-Jul-10	3848	0.124	207
19-Jul-10 – 26-Jul-10	3880	0.209	221
26-Jul-10 – 02-Aug-10	2407	0.105	145
02-Aug-10 – 09-Aug-10	3468	0.264	205
09-Aug-10 – 16-Aug-10	2983	0.132	220
16-Aug-10 – 24-Aug-10	2504	0.097	178
24-Aug-10 – 30-Aug-10	2317	0.083	88
30-Aug-10 – 06-Sep-10	3639	0.346	199
06-Sep-10 – 13-Sep-10	3999	0.702	422
13-Sep-10 – 20-Sep-10	2133	0.076	74
20-Sep-10 – 27-Sep-10	2720	0.309	318
27-Sep-10 – 04-Oct-10	2480	0.568	250
04-Oct-10 – 11-Oct-10	5255	0.926	917
11-Oct-10 – 18-Oct-10	1040	0.529	245
18-Oct-10 – 25-Oct-10	2452	0.178	101
25-Oct-10 – 01-Nov-10	2968	0.308	232
01-Nov-10 – 08-Nov-10	2455	0.237	95
08-Nov-10 – 15-Nov-10	1353	0.206	49
15-Nov-10 – 22-Nov-10	639	0.398	81
22-Nov-10 – 29-Nov-10	1120	0.260	94
29-Nov-10 – 06-Dec-10	2075	0.393	204
06-Dec-10 – 13-Dec-10	1210	0.230	55
13-Dec-10 – 20-Dec-10	1836	0.818	213
20-Dec-10 – 27-Dec-10	1598	0.980	602
Mean	2582	0.343	225
SD	1093	0.259	185

Table 2.1. Radionuclides in precipitation in the 10 m<sup>2</sup> rain collector at Risø (cf. Fig. 1), July - December 2010. (Unit: Bq m<sup>-3</sup>)

Month	<sup>7</sup> Be	<sup>137</sup> Cs	<sup>210</sup> Pb
July	2833	0.215	154
August	1544	0.088	106
September	1620	0.160	133
October	1630	0.063	100
November	1232	0.026	27
December	620	0.079	80

Table 2.2. Radionuclides in precipitation in the 10 m<sup>2</sup> rain collector at Risø (cf. Fig. 1), July - December 2010. (Unit: Bq m<sup>-2</sup>)

Month	Precipitation (m)	<sup>7</sup> Be	<sup>137</sup> Cs	<sup>210</sup> Pb
July	0.050	143	0.0108	7.8
August	0.188	291	0.0165	20.0
September	0.041	67	0.0066	5.5
October	0.064	104	0.0040	6.4
November	0.081	100	0.0021	2.2
December	0.063	39	0.0050	5.1
Sum	0.487	744	0.0450	47.0

*Table 2.3. Tritium in precipitation collected at Risø (cf. Figs. 1, 2.3.1 and 2.3.2). July - December 2010. (Unit: kBq m<sup>-3</sup>)*

Month	1 m <sup>2</sup> rain collector*	10 m <sup>2</sup> rain collector*
July	2.1	< 2.1
August	< 2.1	2.2
September	< 2.1	< 2.1
October	< 2.1	3.3
November	< 2.1	< 2.1
December	< 2.1	< 2.1
Double determinations*.		

*Table 2.4. Tritium in precipitation collected at Risø (cf. Fig. 1). July - December 2010. (Unit: kBq m<sup>-2</sup>)*

Month	Precipitation (m)	1 m <sup>2</sup> rain collector	10 m <sup>2</sup> rain collector
July	0.050	0.105	< 0.105
August	0.188	< 0.395	0.414
September	0.041	< 0.086	< 0.086
October	0.064	< 0.134	0.211
November	0.081	< 0.170	< 0.170
December	0.063	< 0.132	< 0.132
Sum	0.487	< 1.023	< 1.118



*Table 3.1. Radionuclides in sediment samples collected at Bolund in Roskilde Fjord.(cf. Fig. 3.1) July - December 2010. (Unit: Bq kg<sup>-1</sup> dry)*

Date	<sup>137</sup> Cs	K*
5 July	1.8	16.7
*Unit: g kg <sup>-1</sup> dry		

*Table 4.1. Radionuclides in seawater collected in Roskilde Fjord (cf. Fig. 4.1) July - December 2010. (Unit: Bq m<sup>-3</sup>)*

Date	<sup>137</sup> Cs
1 July	12.4

*Table 4.2. Tritium in seawater collected in Roskilde Fjord (Risø pier) (cf. Fig. 4.2) July - December 2010.*

Month	kBq m <sup>-3</sup>
July	< 2.1 *
August	< 2.1 *
September	< 2.1 *
October	< 2.1 *
November	2.3 *
December	< 2.1 *
* Double determinations	

Table 5.1. Radionuclides in grass (\* snow) collected at Risø (near the Waste Treatment Station (cf. Fig. 1)), July - December 2010. (\*\*Measured on bulked ash samples)

Week no. or month	Date	K (g kg <sup>-1</sup> fresh)	<sup>137</sup> Cs (Bq kg <sup>-1</sup> fresh)	<sup>137</sup> Cs (Bq m <sup>-2</sup> )
27	5 July	7.9	<0.6	
28	12 July	6.5	<0.6	
29	19 July	4.5	<0.5	
30	26 July	5.5	<0.6	
31	2 August	4.7	<0.5	
32	9 August	4.8	<0.5	
33	16 August	5.6	<0.6	
34	23 August	4.0	<0.4	
35	30 August	4.3	<0.4	
36	6 September	4.5	<0.5	
37	13 September	4.2	<0.5	
38	20 September	4.1	<0.5	
39	27 September	5.4	<0.5	
40	4 October	5.9	<0.6	
41	11 October	3.9	<0.4	
42	18 October	4.9	<0.4	
43	25 October	3.9	<0.4	
44	1 November	3.5	<0.4	
45	8 November	2.3	<0.5	
46	15 November	3.9	<0.5	
47	22 November	2.6	<0.3	
48	29 November*	-	<0.3	
49	6 December*	<0.2	<0.3	
50	13 December*	<0.1	<0.3	
51	20 December*	<0.2	<0.4	
52	27 December*	<0.1	<0.1	
**July		6.1	0.068	0.016
**August		5.4	0.118	0.057
**September		5.6	0.074	0.034
**October		4.8	0.027	0.012
**November		3.6	0.118	0.058
**December		-	-	-

*Table 5.2. Radionuclides in Fucus vesiculosus collected at Bolund in Roskilde Fjord. July - December 2010. (Unit: Bq kg<sup>-1</sup> dry)*

Date	<sup>137</sup> Cs	K*	% dry matter
5 July	4.3	35	20
*Unit: g kg <sup>-1</sup> dry			

Table 7.1. Waste water collected at Risø (cf. Fig. 1), July - December 2010.

Week number	eqv. mg KCl l <sup>-1</sup>	<sup>137</sup> Cs (Bq m <sup>-3</sup> )	<sup>131</sup> I (Bq m <sup>-3</sup> )	<sup>226</sup> Ra (Bq m <sup>-3</sup> )
27	139	163	<113	<214
28	115	178	<119	<220
29	125	106	<113	<212
30	97	<122	<116	<213
31	92	<119	<118	<217
32	93	<131	<121	<234
33	48	<123	<126	<243
34	43	<110	<110	<207
35	58	<116	<119	<219
36	111	<109	<111	<208
37	223	453	<121	<230
38	128	418	<123	<248
39	112	<115	<113	<212
40	143	184	<121	<222
41	99	<104	<115	<221
42	93	91	<64	337
43	76	<120	<117	428
44	66	<114	<114	<207
45	54	<122	<121	<230
46	48	<111	<115	<217
47	38	<109	<114	<213
48	35	<112	<109	<209
49	32	<109	<115	<213
50	28	<99	<106	<204
51	40	<116	<115	<219
52	56	<72	<135	<156
Mean	84.3			
SD	45.5			

*Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period May 2010 – October 2010. (Results are normalized to  $\text{nSv h}^{-1}$ )*

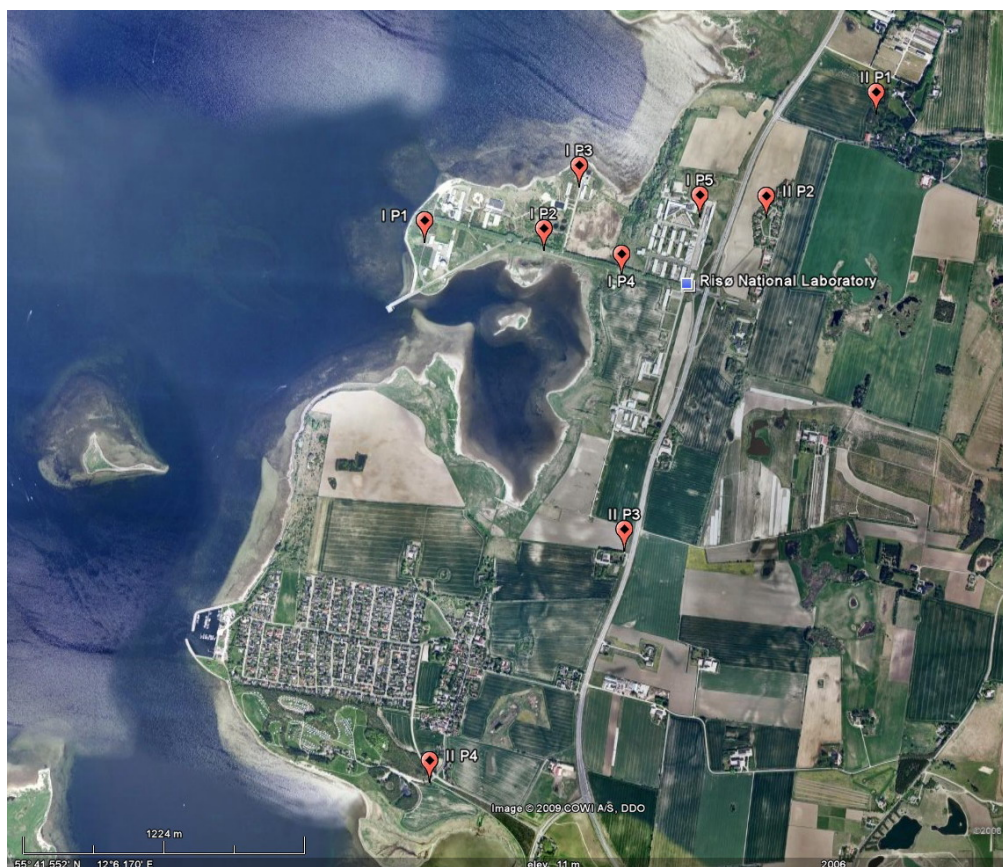
Location	$\text{nSv h}^{-1}$
1	50
2	46
3	41
4	57
5	50
6	56
Mean	50

*Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period May 2010 – October 2010. (Results are normalized to nSv h<sup>-1</sup>)*

Risø zone	Location	nSv h <sup>-1</sup>
I	1	36
I	2	54
I	3	107
I	4	63
I	5	-
Mean		65
II	P1	69
II	P2	80
II	P3	79
II	P4	42
Mean		68
III	P1	58
III	P2	61
III	P3	61
Mean		60
IV	P1	42
IV	P2	45
IV	P3	53
IV	P4	60
IV	P5	47
IV	P6	46
IV	P7	59
Mean		50
V	P1	56
V	P2	52
V	P3	63
V	P4	41
V	P5	58
V	P6	45
V	P7	50
V	P8	63
V	P9	62
V	P10	60
Mean		55

*Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) July - December 2010. Measured with a NaI(Tl) detector. (Unit: nSv h<sup>-1</sup>)*

Risø zone	Location	July	October
I	P1	36	40
I	P2	47	48
I	P3	348	367
I	P4	41	42
I	P5	59	43
Mean		106	108
II	P1	39	42
II	P2	39	41
II	P3	36	38
II	P4	39	41
Mean		38	40
III	P1		46
III	P2		47
III	P3		41
Mean			45
IV	P1		38
IV	P2		48
IV	P3		43
IV	P4		45
IV	P5		40
IV	P6		43
IV	P7		43
Mean			43
V	P1		36
V	P2		48
V	P3		52
V	P4		41
V	P5		46
V	P6		45
V	P7		39
V	P7a		45
V	P8		41
V	P9		47
V	P10		35
Mean			43



*Fig. 1. Locations for measurements of gamma-background radiation Zone I and II (cf. Tables 8.2 and 8.3)*



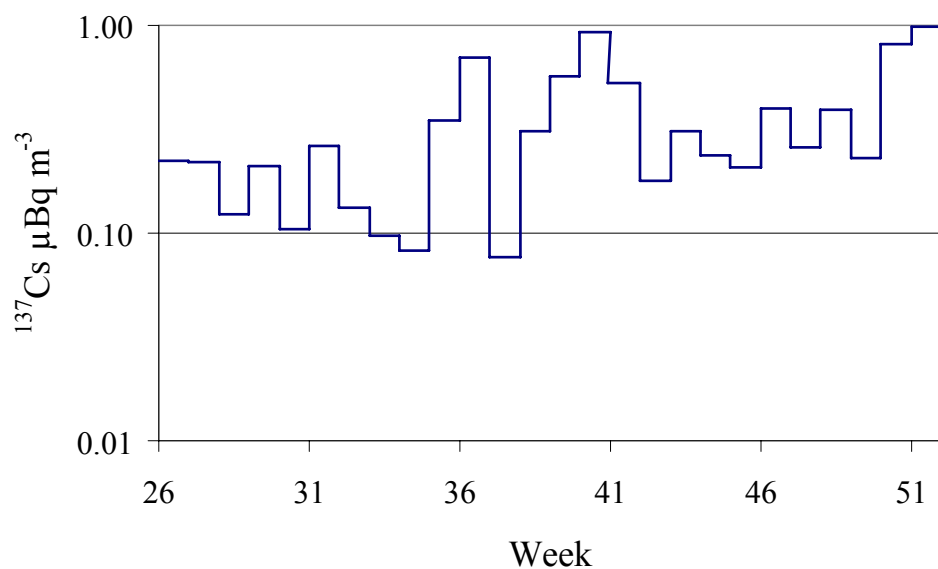


Fig. 1.1. Caesium-137 in ground level air collected at Risø in July-December 2010. (Unit:  $\mu\text{Bq m}^{-3}$ )

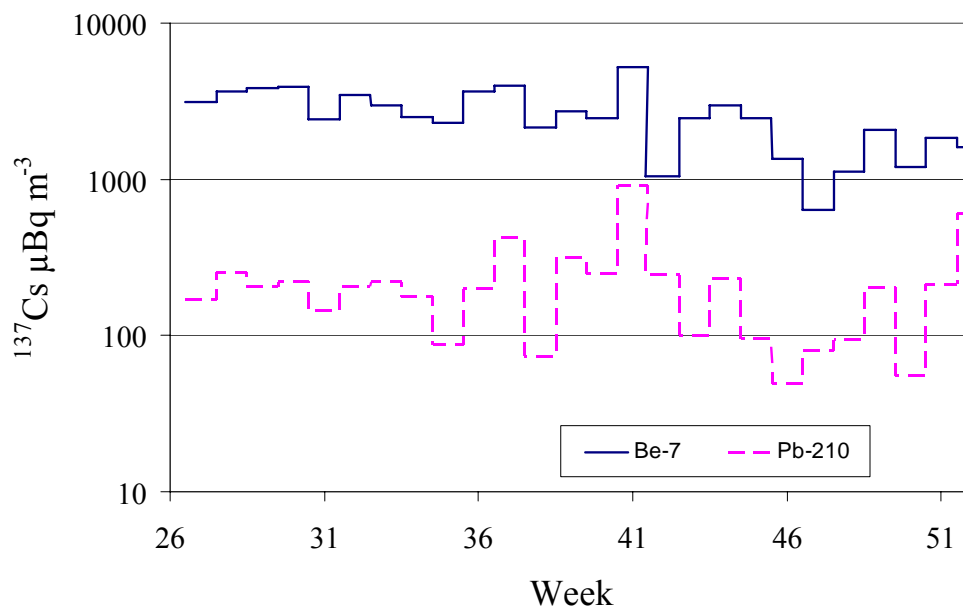


Fig. 1.2. Beryllium-7 and lead-210 in ground level air collected at Risø in July-December 2010. (Unit:  $\mu\text{Bq m}^{-3}$ )

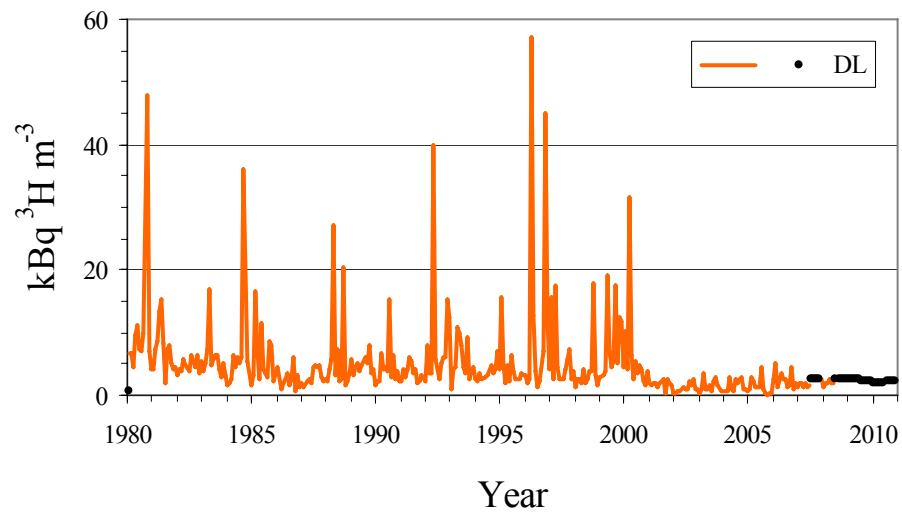


Fig. 2.3.1. Tritium in precipitation collected at Risø ( 1 m<sup>2</sup> rain collector ) 1980 - 2010. (Unit: kBq m<sup>-3</sup>; DL = detection limit )

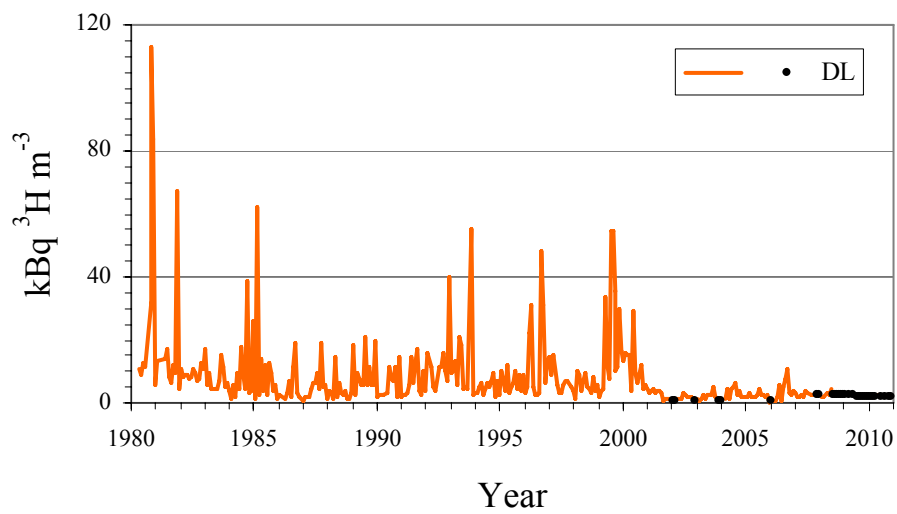
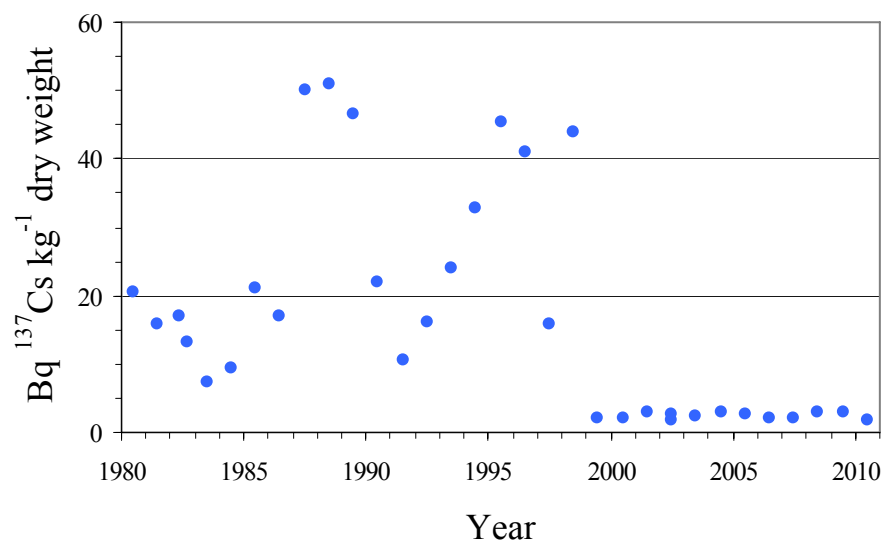


Fig. 2.3.2. Tritium in precipitation collected at Risø ( 10 m<sup>2</sup> rain collector ) 1980 - 2010. (Unit: kBq m<sup>-3</sup>; DL = detection limit )



*Fig. 3.1. Caesium-137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2010. (Unit: Bq kg<sup>-1</sup> dry matter)*

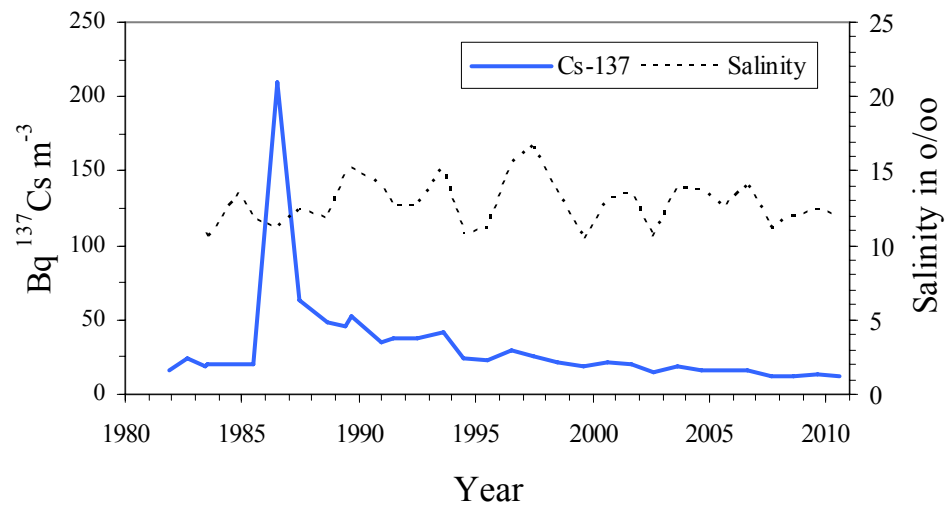


Fig. 4.1. Caesium-137 in seawater collected in Roskilde Fjord 1980 - 2010.  
(Unit:  $\text{Bq m}^{-3}$ )

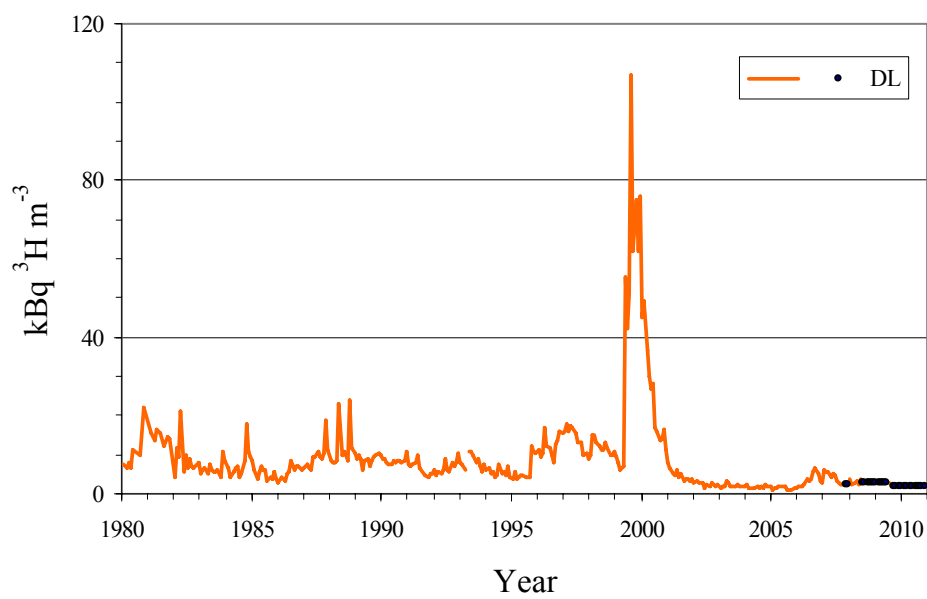
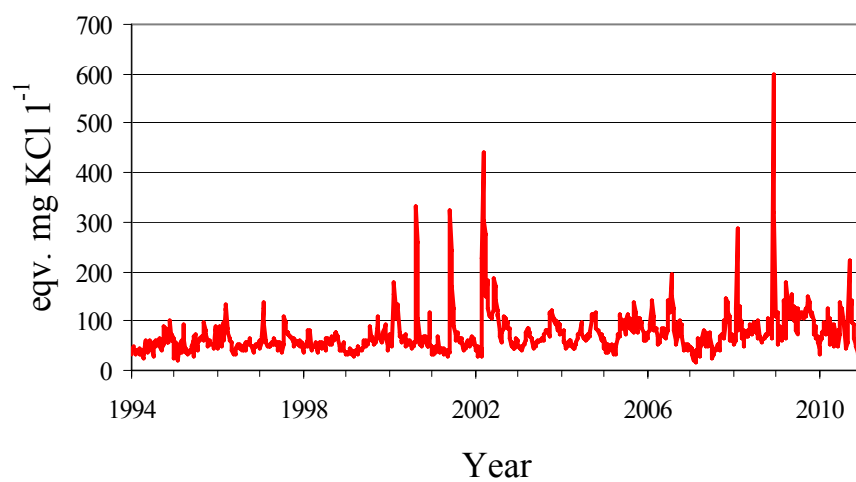
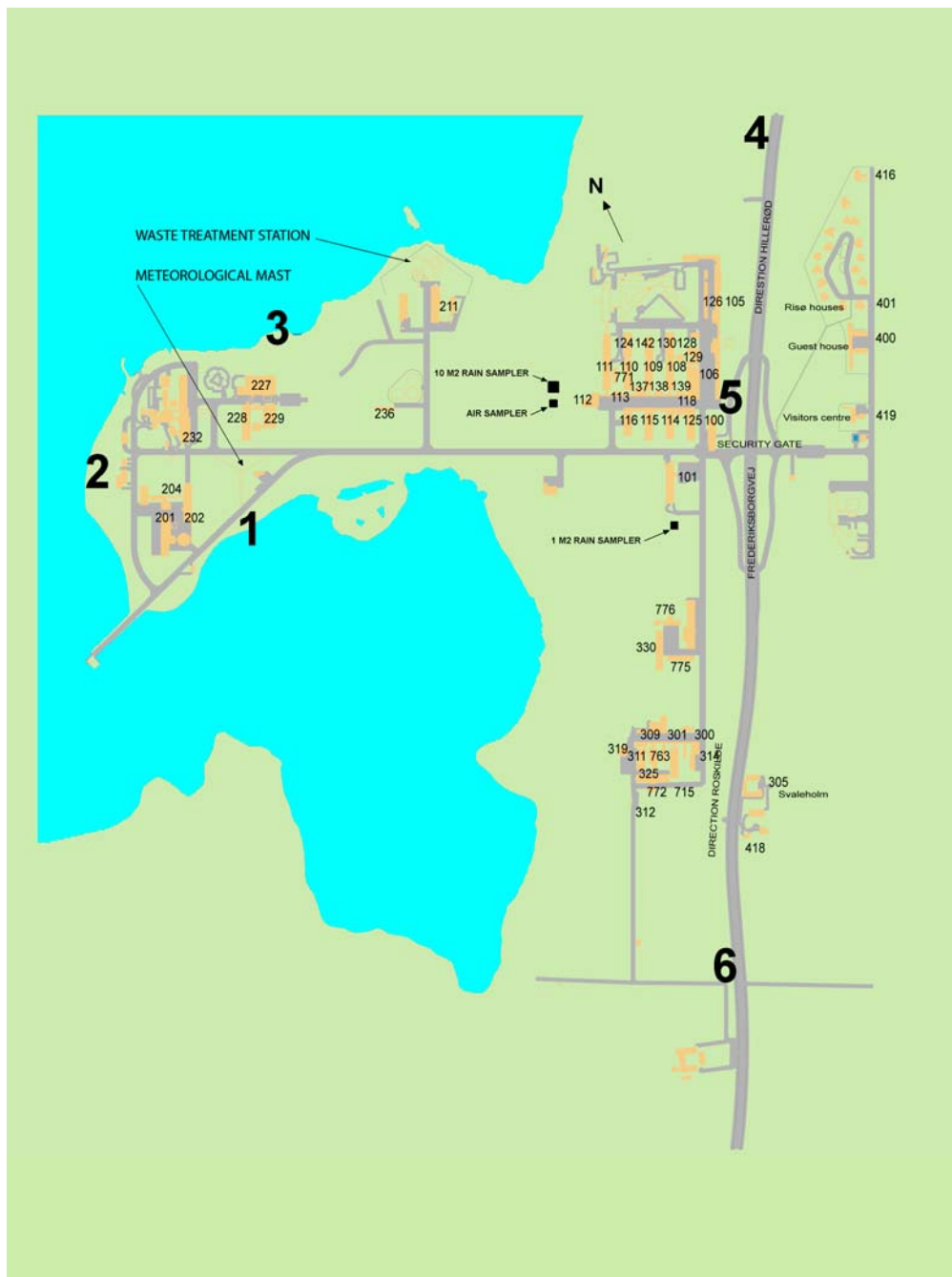


Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2010.  
(Unit:  $\text{kBq m}^{-3}$ ; DL = detection limit)



*Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2010.  
(Unit: eqv. mg KCl l<sup>-1</sup>)*



*Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).*



*Fig. 8.2. Locations for measurements of background radiation around Risø in Zones III, IV and V.*





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